INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS

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The IMA was founded by and receives major support from the National Science Foundation.

IMA NEWSLETTER # 329

1 March–2 April 2004

2003–2004 Program

PROBABILITY AND STATISTICS IN COMPLEX SYSTEMS

See http://www.ima.umn.edu/complex/ for a full description of the 2003–2004 program on Probability and Statistics in Complex Systems: Genomics, Networks, and Financial Engineering

IMA schedules are subject to revision, particularly during workshops. See http://www.ima.umn.edu/~seminar/sched and http://www.ima.umn.edu/newsltrs/ for the latest scheduling information.

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PART I: NEWS AND NOTES

Change to the Industrial Advisory Board

Jon Kettenring is retiring from his position on the Industrial Advisory Board and Tami Carpenter is joining, as our new contact at Telcordia. Thanks to Jon for his many years of service to the IMA, both on the Industrial Advisory Board and on the Board of Governors. Welcome to Tami.

PARTICIPATING INSTITUTIONS: Consiglio Nazionale delle Ricerche (CNR), Georgia Institute of Technology, Indiana University, Iowa State University, Kent State University, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Michigan State University, Mississippi State University, Northern Illinois University, Ohio State University, Pennsylvania State University, Purdue University, Rice University, Sandia National Laboratories, Seoul National University (BK21 Math-SNU), Seoul National University (SRCCS), Texas A&M University, University of Chicago, University of Cincinnati, University of Delaware, University of Houston, University of Illinois (Urbana), University of Iowa, University of Kentucky, University of Maryland, University of Michigan, University of Minnesota, University of Notre Dame, University of Pittsburgh, University of Wisconsin, University of Wyoming, Wayne State University.

PARTICIPATING CORPORATIONS: ExxonMobil, Ford, General Electric Company, General Motors, Honeywell, IBM, Lockheed Martin, Lucent, Motorola, Schlumberger, Siemens, Telcordia Technologies, 3M.

Version of April 7, 2004

IMA Tutorial:

Control and Pricing in Communication and Power Networks

7 March 2004
Speakers: Christopher L. DeMarco (University of Wisconsin-Madison), Thomas G. Kurtz (University of Wisconsin-Madison), Ruth J. Williams (University of California, San Diego),

See http://www.ima.umn.edu/complex/winter/t4.html

IMA Workshop:

Control and Pricing in Communication and Power Networks

8-13 March 2004
Organizers: Christopher L. DeMarco (University of Wisconsin-Madison), Thomas G. Kurtz (University of Wisconsin-Madison), Ruth J. Williams (University of California, San Diego),

See http://www.ima.umn.edu/complex/winter/c6.html

Special IMA Short Course:

Tools for Modeling and Data Analysis in Finance/Asset Pricing

29 March-2 April 2004
Speakers: Marco Avellaneda (Courant Institute of Mathematical Sciences), Blaise G. Morton (EBF Funds), Srdjan D. Stojanovic (University of Cincinnati), Carlos Fabian Tolmasky (Cargill, Inc.),

See http://www.ima.umn.edu/complex/spring/sc2.html

IMA Public Lecture:

Behavioral Finance - The Closed End Fund Puzzle

30 March 2004, 7:00 pm, Room 100 Smith Hall
Speaker: Stephen A. Ross (MIT)

See http://www.ima.umn.edu/public-lecture/2003-04/ross/index.html

IMA Website

Comments or suggestions concerning the IMA website may be addressed to

webmaster@ima.umn.edu.

In particular, we appreciate any information about World-Wide Web links appropriate to current and upcoming IMA programs.

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PART II: Schedule for 1 MARCH–2 APRIL 2004

Monday, March 1

The 3:00 IMA break will be in Lind Hall 400.

Tuesday, March 2

The 10:30 IMA break will be in Lind Hall 400.

Wednesday, March 3

The 10:30 IMA break will be in Lind Hall 400.

Thursday, March 4

The 10:30 IMA break will be in Lind Hall 400.

COMPLEX SYSTEMS SEMINAR, Lind Hall 409:

1:30 pm **Ilze Ziedins** Multicasting and Phase Transitions in Tree Loss Networks
University of Auckland

Abstract: We consider a generalisation of the hard-core model on regular trees that arises in statistical mechanics. This generalisation is motivated by multicasting in queueing and loss networks. Multicasting occurs when a transmission is made to a group of individuals from a single site, instead of just having a simple end-to-end connection. An example of this in the loss network setting is a conference call. We analyse a model of a regular tree loss network that supports both unicast calls that require unit capacity on a single link, and multicast calls that require unit capacity on all the links emanating from a node. At sufficiently high arrival rates for the multicast calls, the network can exhibit a phase transition, leading to unfairness due to spatial variation in the multicast blocking probabilities. The dependence of the phase transition on various parameters will be discussed, as well as the effect of simple controls within the network. Recent work showing that the phase transitions can be nonmonotone will also be described. This is joint work with Kavita Ramanan, Anirvan Sengupta and Brad Luen.

Friday, March 5

The 10:30 IMA break will be in Lind Hall 400.

IMA/MCIM INDUSTRIAL PROBLEM SEMINAR, 570 Vincent Hall:

1:25pm	**Curt Flory** Agilent Technologies	Intuitive Understanding of Grating-Coupled Radiation Using Green's Function Methods

Abstract: Radiation scattered from diffraction gratings on the surface of waveguides is analyzed using the Volume Current Method. The framework allows separation of the effects of the grating array global periodicity and the effects of the specific shape of the individual grating elements. A straightforward analogy between the influence of the grating element shape and the behavior of phased-antenna array systems allows a clear and intuitive understanding of the effects of blazed gratings on the directionality of grating-coupled radiation.

Sunday, March 7

IMA Tutorial:

Control and Pricing in Communication and Power Networks

7 March 2004

Speakers: Christopher L. DeMarco (University of Wisconsin-Madison), Thomas G. Kurtz (University of Wisconsin-Madison), Ruth J. Williams (University of California, San Diego),

See http://www.ima.umn.edu/complex/winter/t4.html

The tutorial will introduce some of the main issues in the design and operation of communication and power networks and will provide background helpful in understanding the material to be presented during the Workshop. While the connectivity of power and communications networks may be similar, the physics of these networks is very different. The tutorial and the following workshop should provide a better understanding of both the similarities and the differences in these systems.

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30	**Coffee and Registration**	Reception Room EE/CS 3-176
9:00	**Douglas N. Arnold, Scot Adams, and Organizers**	Welcome and Introduction
9:15–10:15 and 1:30–2:45	**Christopher L. DeMarco** University of Wisconsin-Madison	Network Control, Pricing, and the Role of Cascading Failure Phenomena in Electric Power Grids

Abstract: While sharing a number of broad qualitative features with problems in control and resource allocation for other large scale networks such as the internet, electric power grids present a range of unique challenges. Three major technological characteristics distinguish control and pricing problems in electric power: (i) the commodity being delivered is inefficient to store, so production tracks consumption across the entire interconnected grid, nearly instantaneously; (ii) the majority of branches in the delivery network are passive elements, with branch flows dictated by nonlinear relations to nodal boundary conditions, rather than by direct control; (iii) many constraints on operation represent physical limits whose violation can yield costly equipment damage and threats to human safety. Adding to the complexity of analysis is the U.S. electric power system's uneven regulatory policy transition, in which certain physical elements contributing to grid control operate in competitive markets (generators), while the others (e.g., switched capacitor banks, adjustable tap transformers) operate under the authority of regulated regional transmission monopolies.

This tutorial will give an overview of the mathematical models used to predict both dynamic and steady state performance of physical quantities in the electric power grid. Starting from the nonlinear constraints on network power flow, and the

nature of financial offers and bids for electric power production and consumption, the relation of so-called "locational marginal prices" to an underlying optimization formulation will be reviewed. Issues in developing effective offer and bid strategies from these locational prices, and related issues for setting regulatory structures to govern these, will be highlighted. The tutorial will conclude with an overview of techniques for predicting cascading failure phenomena. Research to improve these techniques could play a key role in balancing operational strategies that favor efficiency under "normal" conditions, versus strategies that favor mitigation of risk of extremely high cost, low probability failure events such as the eastern U.S. blackout of August 2003.

10:45–12:00 and 3:15–4:30	**R. Srikant** University of Illinois, Urbana-Champaign	The Architecture of the Internet/Pricing and Control of the Internet

Abstract: n the first part of the tutorial, we will present a general introduction to the architecture of the Internet. Various protocols for scheduling, admission control, routing and congestion control will be introduced. We will then focus our attention on TCP, the widely-used protocol for file transfer in the Internet today. Jacobson's TCP congestion control algorithm has been remarkably successful in regulating file transfers and facilitating the phenomenal growth of the Internet over the last decade. This congestion control mechanism was designed for networks where the required data rate per user is small (less than one Mbps) and the round-trip times are small (of the order of a few milliseconds). However, access speeds, application requirements and file transfer distances continue to increase. Using simple tools from queueing theory and delay-differential equations, we will illustrate the need to redesign the congestion management mechanisms in the Internet to efficiently deliver high data rates over long distances.

In the second part of the tutorial, we will concentrate on pricing and control mechanisms that have recently led to the design of scalable TCP protocols. Starting with Kelly's model of resource allocation in a heterogeneous Internet, it will be shown that congestion management can be viewed as a distributed algorithm for fair resource allocation in the Internet. We will illustrate the use of tools from convex optimization, stochastic processes and control theory in designing congestion control mechanisms at the end users and congestion indication mechanisms at the routers that deliver an efficient loss-free, delay-free service over the Internet.

4:30 **Discussion**

Monday, March 8

IMA Workshop:

Control and Pricing in Communication and Power Networks

8-13 March 2004

Organizers: Christopher L. DeMarco (University of Wisconsin-Madison), Thomas G. Kurtz (University of Wisconsin-Madison), Ruth J. Williams (University of California, San Diego),

See http://www.ima.umn.edu/complex/winter/c6.html

This workshop focuses on stochastic modeling, analysis, and control for communication and power networks. Spiraling demand for internet services and the highly decentralized structure of the internet present unique challenges to traditional methods of system control and resource pricing. Deregulation of electric power markets gives rise to a broad range of critically important problems concerned with the dynamic interaction of electricity markets, power generation, and complex power distribution networks. Reduced complexity models based on fluid and diffusion approximations, large deviations theory, aggregation methods, spectral methods, graph-based algorithms, and other analytical methods will be covered. Models of real-time markets with network constraints, risk management (futures markets), pricing, and system reliability will be addressed. Control models employing pricing mechanisms will be an important focus.

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30	**Coffee and Registration**	Reception Room EE/CS 3-176
9:15	**Douglas N. Arnold, Scot Adams, and Organizers**	Welcome and Introduction
9:30	**Marija D. Ilic** Carnegie Mellon University	A Multi-Layered Approach to Transmission Provision and Pricing in the Electric Power Networks

Abstract: In this talk, I review three qualitatively different mechanisms of delivering electric power under open access. The first approach is based on optimizing power dispatch under transmission constraints, and providing a bundled electricity price signal which incorporates both energy and systems support charges. This approach is based on the original notions of spot electricity prices [1] underlies today's spot markets in several parts of the U.S. electric grid and is recommended by Professor Hogan at Harvard [1a]. The second approach allows for the electricity trading process to be separate from the transmission system support needed to deliver the traded power. This was introduced by several Berkeley faculties in [2]. The only constraint is that the market participants trade under the technical constraint that the transmission limits are not exceeded. There is no transmission price signal in this method. Finally, the so-called two-level transmission provision and pricing was introduced by Ilic et al at MIT in [3]. This method is based on iterative information exchange between the market participants and the transmission system provider: The market participants inform a system provider concerning the location and amount of power they wish to inject into particular locations within the electric grid, and the system provider, based on all given requests, optimizes use of the available transmission capacity and sends the transmission price signal to the market participants. The market participants adjust their requests, the delivery price gets adjusted, and the transactions are implemented. It is documented in [3] that at the equilibrium all three schemes result in the same optimum under several simplifying assumptions.

In this paper we review the assumptions under which these transmission provision and pricing schemes are designed and compared to:

Analyze current industry proposals for transmission provision and pricing in light of the three methods.

Propose a generalization of the method described in [3] which allows for a multi-layered reliability-related risk management and valuation of system support.

Summarize recent simulation results [4, 5, 6] illustrating typical outcomes of the multi-layered transmission provision and pricing.

1.1.3 References:

[1] Schweppe, F., Caramanis, M., Tabors, R., Bohn, R., Spot Pricing of Electricity, Kluwer Academic Publishers, Boston, MA, 1988.

[1a] Hogan, WW, Contract networks for electric power transmission, Journal of Regulatory Economics, 1992, pp. 211-242.

[2] Wu, FF, Varaiya, P., Spiller, P., Oren, S., Coordinated multilateral trades for electric power networks: theory and implementation. POWER Report PWR-031, Univ. of California Energy Institute, June 1995.

[3] Allen, E., M. Ilic and Z. Younes, "Providing for Transmission in Times of Scarcity: An ISO Cannot Do it All," Electrical Power and Energy Systems, pp. 147-163, 1999 (Special Issue on Deregulation).

[4] Ilic, M., Hsieh, E., Ramanan, P., Transmission Pricing of Distributed Multilateral Energy Transactions to Ensure System Security and Guide Economic Dispatch, IEEE Trans. on Power Systems, May 2003.

[5] Wang, H, Ilic, M., Vogelsang, I., Multi-Layered Unbundled Delivery of Electricity Service to Customers under Normal Conditions, Proc. of the PES IEEE General Meeting, June 2004, Denver, CO, paper no 04GM1285.

[6] Minoia, A., Ernst, D., Ilic, M., Market dynamics driven by the decision making of both power producers and transmission owners, Proc. of the PES IEEE General Meeting, June 2004, Denver, CO.

10:20	**Discussion**

10:30	**Coffee Break**	Reception Room EE/CS 3-176
11:00	**Jean Walrand** University of California, Berkeley	Pricing and Revenue Sharing in Multi-Provider Networks

Abstract: One critical challenge facing the telecommunications industry is to increase the Internet's profitability for network service providers. Currently, the network providers have limited economic incentives to invest in technology for value-added services. This situation results in an untapped potential of the network. Two ingredients are essential for improving the situation.

First, the network must implement mechanisms that enable providers to charge services differentially based on their characteristics. Second, the mechanisms must make it possible for the network providers to share the revenues fairly. If they can charge more for better services and collect a fair share of the resulting increased revenues, the network providers have the incentive to provide services that users value more.

In this talk, we describe some results on service differentiation and a protocol for revenue sharing among network providers. The protocol uses a new form of packet marking.

This is joint work with Linhai He, a Ph.D. Candidate at UCB.

11:50	**Discussion**	
12:00	**Lunch Break**	
1:30	**Ross Baldick** The University of Texas at Austin	Stability of Supply Function Equilibria: Implications for Daily Versus Hourly Bids in a Poolco Market

Abstract: We consider a supply function model of a poolco electricity market where demand varies significantly over a time horizon such as a day and also has a small responsiveness to price. We show that a requirement that bids into the poolco be consistent over the time horizon has a significant influence on the market outcome. In particular, although there are many equilibria yielding prices at peak that are close to Cournot prices, such equilibria are typically unstable and consequently are unlikely to be observed in practice. The only stable equilibria involve prices that are relatively closer to competitive prices. We demonstrate this result both theoretically under somewhat restrictive assumptions and also numerically using both a three firm example system and a five firm example system having generation capacity constraints. This result contrasts with markets where bids can be changed on an hourly basis, where Cournot prices are possible outcomes. The stability analysis has important policy implications for the design of day-ahead electricity markets.

Joint work with William Hogan Center for Business and Government John F. Kennedy School of Government Harvard University.

2:20	**Discussion**	
2:30	**Coffee Break**	Reception Room EE/CS 3-176
3:00	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.
3:30	**Group Photo**	

3:40	**IMA Tea and more (with Poster Session)**	IMA East, 400 Lind Hall

poster	**James Carson** RisQuant Energy	Weather Simulator as Component of Power Market Monte Carlo Simulator

Abstract: Monte Carlo simulation has become the principal means by which power assets may be valued since there exist few reliable analytic methods. It is well understood that weather has an important influence on load and price in the electric power industry. RisQuant Energy has developed a method whereby simulated weather can be incorporated as a component into a comprehensive power market simulator. Each weather simulator produces hypothetical strands of simulated weather that are statistically consistent with the location's long term history. The weather simulation component drives the market price and load simulators that, in turn, drive the valuation of physical and financial power assets.

For the purposes of this poster session, the model for the weather station BOS (Boston) has been fully articulated. 'Weather' was defined as the average of the daily high and low. For the BOS model, one hundred years of daily history was transformed conventionally, mapped to a sine wave with an annual period, and standard regression procedures applied. The residuals were then washed through an autoregression procedure to complete the model. Those residuals were determined to be normally distributed white noise. The statistical results were then coded into a function call with the date and previous simulated weather as arguments.

poster	**Linhai He** University of California - Berkeley	Issues in Pricing Internet Services

Abstract: One of the critical challenges facing the telecommunications industry today is to increase the profitability for Internet service providers. For historical reasons, the current Internet protocol stack lacks basic features needed to implement efficient economic mechanisms. Consequently, the providers have limited economic incentives to invest in new technology for value-added services. This results in a stagnant industry and limits the evolution of the Internet.

In this talk, we present pricing schemes that would enable the providers to profit from offering differentiated services and share the increased revenues fairly. We first show that with the commonly accepted Differentiated Services model, if prices are not properly differentiated with respect to service quality, then the system may settle into either unstable or inefficient equilibria. We then discuss how to construct pricing schemes that are stable and lead to socially optimal allocation among users.

Pricing issues become more complex when a service needs to be jointly provided by a network of providers. We first show that if providers are allowed to charge freely in their own interest, then the resulting equilibrium could be inefficient, unfair and may discourage future upgrades to the networks. As an alternative, a simple revenue-sharing policy, under which providers would agree to collaborate for increasing their revenues, can be shown to eliminates all the aforementioned drawbacks. For its implementation, a protocol is constructed based on the predicted outcome of the game, so that providers do not have incentive to cheat. We construct a decentralized algorithm that the providers can use to compute the optimal prices and show that the algorithm is scalable and converges to the improved equilibrium.

poster	**Peter Marbach** University of Toronto	Rate Control in Random Access Networks

Abstract: We study the link congestion problem in contention-based networks such as wireless LAN's. These networks are characterized by the use of a random access protocol for channel access. We assume adaptive users or applications in the sense that their traffic flows are elastic. We further assume that individuals' service requirements can be characterized by demand functions that are price-sensitive. A price-based rate control strategy, where the price indicates the current congestion state, is considered to control channel congestion. The effectiveness of price-based rate control is studied in the context of the classic slotted ALOHA model with an infinite population. The price as the new state variable is dynamically updated based on control parameters and the ternary channel feedback. Our results show that under this model stabilization of the ALOHA channel can be achieved. In particular, by using drift analysis, we prove that the associated Markov chain is positive recurrent. The resulting steady state probability distribution thus characterizes an operating point for the model. Moreover, a desired operating point as such could be selected by proper choice of the control parameters. We also show that service differentiation is realized at the operating point. From a control perspective, where demand functions become

predetermined system parameters, such a price-based scheme offers a simple mechanism to provide service differentiation in a best-effort contention-based network. We also discuss how this scheme can be integrated with price-based rate control for point-to-point networks to provide end-to-end rate control.

Joint work with Clement Yuen.

poster	**John Musacchio** University of California, Berkeley	Game Theoretic Modeling of Wi-Fi Pricing

Abstract: In this work we study the relationship between a WLAN owner acting as a wireless access provider and a paying client. We model the interaction as a dynamic game in which the players have asymmetric information C the client knows more about her utility function than the access provider knows. We find that if a client has what we call a web browser utility function, it is a Nash equilibrium for the provider to charge the client a constant price per unit time, and that clients with sufficiently high valuations for the service pay the price. In contrast, we find that if a client has what we call a file transferor utility function, with a bounded file length, the client should be unwilling to pay until the final time slot of her file transfer. We also analyze a Bayesian model in which the provider does not know whether he faces a web browser or file transferor type client, and study the case where there is no bound on the client's file length.

poster	**Asuman Ozdaglar** MIT Sloan School of Management	Flow Control, Routing, and Performance from Service Provider Viewpoint

Abstract: We consider a game theoretic framework to analyze traffic in a congested network, where a profit-maximizing monopolist sets prices for different routes. Each link in the network is associated with a flow-dependent latency function which specifies the time needed to traverse the link given its congestion. Users have utility functions defined over the amount of data flow transmitted, the delays they incur in transmission, and the expenditure they make for using the bandwidth. Given the prices of the links, each user chooses the amount of flow to send and the routes to maximize the utility he receives. We define an equilibrium of user choices given the prices, show its existence and essential uniqueness, and characterize how this equilibrium changes in response to changes in prices. We then define a monopoly equilibrium (ME) as the equilibrium prices set by the monopolist and the corresponding user equilibrium, and characterize this equilibrium.

We also study the performance of the ME relative to the user equilibrium at zero prices and the social optimum, which would result from the choice of a network planner with full information and full control over the flow and routing choices of users. Although equilibria for a given price vector or without prices are typically inefficient relative to the social optimum, we show that the ME achieves full efficiency for the routing problem (i.e., where each user has a fixed amount of data to transmit). Finally, we consider the case where there are multiple service providers competing for users, and show similar characterization and efficiency results.

This is joint work with Daron Acemoglu, Department of Economics, MIT.

poster	**Sujay Sanghavi** U of Illinois, Urbana-Champaign	Optimal Allocation of a Divisible Good to Strategic Buyers

Abstract: We address the problem of allocating a divisible resource to buyers who value the quantity they receive, but strategize to maximize their net payoff (value minus payment). An allocation mechanism is used to allocate the resource based on bids declared by the buyers. The bids are equal to the payments, and the buyers are assumed to be in Nash equilibrium. For two buyers such an allocation mechanism is found that guarantees that the aggregate value is always greater than $\frac{7}{8}$ of the maximum possible, and it is shown that no other mechanism achieves a larger ratio. For a general finite number of buyers an allocation mechanism is given and an expression is given for its worst case efficiency. For three buyers the expression evaluates to 0.8737, for four buyers to 0.8735 and numerical computations suggest that the numerical value does not decrease when the number of buyers is increased beyond four. A potential application of this work is the allocation of communication bandwidth on a single link.

Joint work with Buce Hajek.

poster	**Vinnicombe/Lestas** Cambridge University	Robustness of Optimization Based Internet Congestion Control Models to Deviations from Protocol Structure and Symmetry

Abstract: Scalable stability conditions derived so far for optimization based models of congestion control protocols, can be shown mathematically to hold for arbitrary networks provided the underlying protocol is symmetric. In practical implementations, however, deviation from this symmetry is inevitable. It is hence crucial to establish whether these models are fragile with respect to a relaxation of the symmetry assumption. We prove that this is not the case by presenting scalable, decentralized conditions, that guarantee local stability for models of non-symmetric, TCP like protocols, of arbitrary interconnection. We also illustrate how these conditions converge to those derived for symmetric protocols as the degree of non symmetry becomes smaller. Finally, we show the way the decrease rule in TCP is associated with robust stability to non symmetric deviations from the protocol.

The analysis is based on some recent techniques of bounding the eigenvalues of matrices using convex hulls, by taking advantage of the internal structure of the matrices, which often has an appealing graph theoretic interpretation.

poster	**John Ting-Yung Wen** Rensselaer Polytechnic Institute	Passivity-based Methodology for Network Traffic Management

Abstract: We will present a unifying methodology for distributed optimization for network traffic management, from traffic routing, flow regulation, to power control. The foundation of our work is the concept of passivity, which is motivated by energy conservation or dissipation in physical systems and has long been used in the stability analysis and design of nonlinear feedback systems. It is an ideal tool for network stability analysis and control design due to its applicability to nonlinear systems and close linkage to optimization. Through the passivity approach, we have developed new classes of distributed dynamic optimization algorithms and explicit conditions for their stability and robustness.

Joint work with Murat Arcak and Xingzhe Fan Dept. of Electrical, Computer, & Systems Engineering, Rensselaer Polytechnic Institute, Troy, NY 12180.

poster	**Sichao Yang** Univ. of Illinios, Urbana-Champaign	An Efficient Mechanism for Allocation of a Divisible Good with Its Application to Network Resource Allocation

Abstract: We propose an efficient mechanism for allocation of a divisible good. Strategic buyers play a game by submitting bids to the seller. The seller allocates the good in proportion to the bids and charges the buyers nonuniform prices according to the mechanism. Under some mild conditions on the valuation functions of the buyers, there is a unique NEP and the allocation at the NEP is efficient. The prices charged to the buyers at the NEP are bounded above, and can be made arbitrarily close to the market clearing price for price-taking buyers. The relationship to work of Vikrey-Clark-Groves, Johari and Tsitsiklis, and Sanghavi and Hajek is discussed.

poster	**Lei Ying** U of Illinois - Urbana-Champaign	Global Stability of Internet Congestion Controllers with Heterogeneous Delays

Abstract: We study the problem of designing globally stable, scalable congestion control algorithms for the Internet. Prior work has primarily used linear stability as the criterion for such a design. Global stability has been studied only for single node, single source problems. Here, we obtain conditions for a general topology network accessed by sources with heterogeneous delays. We obtain a sufficient condition for global stability in terms of the increase/decrease parameters of the congestion control algorithm and the price functions used at the links.

Tuesday, March 9

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176
9:30	**Marty Reiman** Lucent Technologies	Revenue Management for a Telecommunications Network

Abstract: We consider two related 'revenue management' problems for a telecommunications network. In both problems there is a fixed network consisting of a set of interconnected links, each with a specified capacity. There are also several

customer classes, each of which is associated with a route in the network. Customers contract in advance for a fixed route over a long term period (e.g., six months). We assume that the contract interval begins at the same time, T, for all customers. In both problems the objective is to maximize the total expected revenue obtained during [0,T]. In the first problem the arrival rates depend on the posted prices for the various routes according to a known demand function, and we consider the problem of dynamically choosing the prices over [0,T]. In the second problem we assume fixed prices and arrival rates, and use admission control.

When the bandwidth on all of the links is large, which is typically true in practice, an asymptotic approach can be used to obtain good policies for both problems. Fluid level (strong law of large numbers) results yield an 'open loop' policy for each problem. Diffusion (central limit theorem) analysis yields 'corrections' to the fluid policies that perform extremely well.

Based on joint work with Rami Atar and Qiong Wang.

10:20	**Discussion**	
10:30	**Coffee Break**	Reception Room EE/CS 3-176
11:00	**Fernando L. Alvarado** University of Wisconsin, Madison	The Role of Uncertainty on Bidding Strategies for Power System Markets

Abstract: Bidding by market participants is the cornerstone of power markets. It is typically assumed that the optimal bidding strategy in uniform price auctions is to bid marginal production costs in the absence of market power. However this observation is only valid under some restrictive assumptions. In general, even for a price-taker in "simple" uniform price auction markets, optimal bidding in electricity markets requires more complex strategies and depends to a nontrivial extent on the statistical characterization of the price uncertainty of markets. This is because of two main reasons. One, "simple" uniform price electricity market auctions involving more than one product are done sequentially, and expectations of clearing prices in future auctions affect bids in present auctions. Two, the cost characteristics and nature of operational constraints are complex — typically they are non-convex and have significant inter-temporal features — and they affect bids in a complex way. This paper illustrates via simple examples how each of several realities of actual power markets can influence bidding patterns by a generator. The paper is a direct extraction and slight extension of some prior work done by the authors which has been reported on several Web sites. In this study we create a world in which startup and shutdown costs are not negligible, where there may be inter-temporal restrictions as to a generator's ability to operate, and where a bidder has more than one (mutually exclusive) product to offer (in our examples, reserves and energy) and where the market clearing price for the product is uncertain. We restrict our attention to a single generator that is a price taker, meaning that the generator is unable to influence clearing price with its bid. We illustrate four effects: (a) the nature of the uncertain future prices can drastically affect bidding behavior, (b) the volatility parameter associated with the uncertainty and not just its mean value can have an influence on optimal bidding behavior, (c) operational restrictions that influence multi-period bids can have an impact on behavior, and (d) correlation or lack of correlation between the uncertain prices of multiple products offered (energy and reserves in our examples) can affect optimal bidding behavior. We also illustrate how a more "complete" (and consequently more complex) market design can simplify bidding behavior, thus leading to an inherent tradeoff between simplicity of market design and simplicity of bidding behavior.

Joint work with Rajesh Rajaraman

11:50	**Discussion**	
12:00	**Lunch Break**	
1:30	**Andrew M. Odlyzko** University of Minnesota	Pricing and Architecture of the Internet: Historical Perspectives from Telecommunications and Transportation

Abstract: Sophisticated pricing has often been offered as a solution to various assorted deficiencies of the Internet. So far this has not succeeded, and in general historical precedents from telecommunications for introduction of differentiated services and complicated charging methods on the Internet are discouraging.

On the other hand, the history of transportation presents a different picture, with frequent movements towards increasing price discrimination and more complicated pricing (although with many noteworthy reversals). Charging according to the nature of the goods being transported has been and continues to be the norm. Since the incentives to price discriminate are increasing, and the ability to do so is also growing, it is conceivable that telecommunications might break with its historical record and follow the example of transportation. It is therefore of interest to examine the evolution of pricing and quality differentiation in transportation.

2:20	**Discussion**	
2:30	**Coffee Break**	Reception Room EE/CS 3-176
3:00	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.

DIGITAL TECHNOLOGY CENTER, 402 Walter Library:

4:30, in 402 Walter Library	**Reception**	
5:00, in 402 Walter Library	**John N. Tsitsiklis** Massachusetts Institute of Technology	A Game Theoretic View of Efficiency Loss in Network Resource Allocation

Abstract: The internet has evolved into a heterogeneous system, comprised of many users who value their own performance, rather than the efficiency of the system as a whole; as a result, proposals for network resource allocation must be robust against self-interested behavior of the network users. With this motivation, we analyze a network congestion game in which the users of congested finite-capacity links anticipate the effect of their actions on the link prices. We show existence of a Nash equilibrium, discuss uniqueness, and establish that the efficiency of the system drops by no more than 25% relative to the social optimum.

We consider several generalizations, such as: (a) competition for an unconstrained resource which is priced according to its marginal cost; (b) a more general resource allocation mechanism in which a set of producers compete for a limited amount of available resources; (c) a symmetrical situation involving a set of competing suppliers.

This is joint work with Ramesh Johari and Shie Mannor.

Wednesday, March 10

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176
9:30	**John N. Tsitsiklis** Massachusetts Institute of Technology	Efficiency Loss in Resource Allocation and Supplier Selection Games

Abstract: Motivated by certain proposals for network resource allocation, we analyze a simple game in which the users of congested finite-capacity links anticipate the effect of their actions on the link prices. We discuss existence and uniqueness

of a Nash equilibrium, and establish that the efficiency of the system drops by no more than 25% relative to the social optimum. We also discuss the case where the link capacity is elastic but costly. We extend the results to a more general resource allocation mechanism in which a set of producers compete for a limited amount of available resources.

Motivated by electricity markets, we consider an analogous situation involving a set of competing suppliers who bid in order to satisfy a prespecified demand. We show that if each producer's "bid" consists of a supply function within a certain one-parameter family, the efficiency loss at a resulting Nash equilibrium can be bounded and decreases to zero with the number of suppliers.

Finally, we argue that the particular families of demand and supply functions we consider are the only ones that possess certain desirable properties.

This is joint work with Ramesh Johari and Shie Mannor.

10:20	**Discussion**	
10:30	**Coffee Break**	Reception Room EE/CS 3-176
11:00	**Sean P. Meyn** University of Illinois, Urbana-Champaign	Dynamics of Ancillary Service Prices in Power Networks

Abstract: The talk concerns resource allocation, pricing, and performance evaluation in electric power markets. Our ultimate goal is the integration of new approaches to dynamic control of stochastic networks, with recent results concerning the competitive market equilibrium in network industries, to obtain comprehensive approaches to model reduction and control for network-level bulk power systems.

The talk will describe some modest first steps:

(i) A dynamic flow model constructed for a single-consumer model in analogy with a standard stochastic queuing model.

(ii) The approximation of the socially-optimal policy by an explicit threshold policy.

(iii) The inability to sustain the socially-optimal policy as a decentralized market outcome.

Generalizations to complex models are also described.

Joint work with Prof. I-K. Cho, Department of Economics, and Mike Chen, Coordinated Science Laboratory.

Presentation available on-line http://black.csl.uiuc.edu/m̃eyn/pages/IMA04.pdf

11:50	**Discussion**	
12:30	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.

Thursday, March 11

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176
9:30	**George C. Verghese** Massachusetts Institute of Technology	Power Network Dynamics: Questions, Examples, Problems

Abstract: The talk will center on questions related to the modeling, estimation and control of power network dynamics,

and will elaborate on some of these questions with illustrative or evocative examples, some drawn from the work of our group. Problems of potential interest to applied mathematicians will be highlighted. The questions include the following:

How are power networks different from communication networks? What are the components, interconnections and important variables? What is normally known about them, who knows, and when? How can one recognize and expose features that are dynamically important? How does the graph structure of the network affect its dynamic behavior? Are there control strategies that exploit connections between graph structure and dynamics? What sorts of deterministic and stochastic aggregation or simplification are desirable or possible in studying dynamic behavior? What has to be or can be done in a decentralized fashion, and what in centralized fashion? How and when are failures confined, how and when do they cascade out of control?

10:20	**Discussion**	
10:30	**Coffee Break**	Reception Room EE/CS 3-176
11:00	**Shi-Jie Deng** Georgia Institute of Technology	Heavy-tailed GARCH Models: Pricing and Risk Management Applications in Electric Power Markets

Abstract: Energy markets, in particular, electricity markets grow rapidly as a result of the restructuring of electric power industries around the world. An accurate electricity price model is crucial for both asset valuation and risk management applications.

In the first half of the talk, we propose alternative non-Gaussian GARCH models that could potentially capture the aspects of heavy-tail and volatility clustering in electricity spot prices induced by mean-reversion, jumps and stochastic volatility. We estimate these GARCH models by applying a two-step quasi-maximum likelihood scheme. The two-step approach is validated by Monte Carlo simulation. In the second half, we concern the problem of constructing confidence intervals for the conditional quantile (namely, Value-at-Risk) based on a GARCH model with heavy-tailed innovations. This problem has not been addressed in the existing literature to our best knowledge. Two methods are proposed: one is the normal approximation method and the other is the data tilting method. These two methods are compared via Monte Carlo simulation, and are applied to estimate the Value-at-Risk of individual electricity forward contract as well as electricity demands at different trading hubs.

This talk is based on joint works with Wenjiang Jiang and Liang Peng, et. al.

11:50	**Discussion**	
12:00	**Lunch Break**	
1:30	**Bruce Hajek** University of Illinois, Urbana-Champaign	On the Flow of Bits and Bucks in the Internet

Abstract: The Internet is a collection of thousands of autonomous routing domains. The organization is to some extent hierarchical, with a clique of tier 1 networks at the top level. The structure is far from tree-like, due to peering arrangements and multi-homing of networks. We present a general framework for modeling hierarchical networks, based on several methods for aggregation of buyers, and several methods for determining the equivalent demand of a set of agents competing in parallel. Basic questions addressed are the question of when profit functions are unimodal in the offered price or bandwidth offered (so that hill-climbing succeeds in maximizing profit), efficiency of allocation, and transfer of demand through intermediate agents.

In addition, three results are presented regarding the cost of anarchy for flat networks. This work, related to recent work of Johari and Tsitsiklis, addresses the amount of inefficiency caused by strategic behavior of buyers.

Based on joint work with Ganesh Gopal, Sujay Sanghavi, and Sichao Yang.

2:20	**Discussion**	
2:30	**Coffee Break**	Reception Room EE/CS 3-176
3:00	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.
6:00	**Workshop Dinner**	Mangia, 1501 University Ave. SE Minneapolis

Friday, March 12

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176
9:30	**Eva Tardos** Cornell University	Price of Anarchy in Network Games

Abstract: We approach traditional algorithmic questions in networks from the perspective of game theory: we will focus on settings where multiple agents each pursue their own selfish interests, each represented by his own objective function. We will quantify the degradation of quality of solution caused by the selfish behavior of users, and design algorithms that can help mitigate this degradation.

We consider a "selfish" routing in which each network user routes its traffic on the minimum-latency path available to it, ignoring the latency of all other users. We compare this "selfish" routing to a social optimum, where the objective is to route traffic such that the sum of all travel times—the total latency—is minimized. In general the "selfish" assignment of traffic to paths will not minimize the total latency, i.e., the lack of central regulation degrades network performance. In this talk we will quantify the degradation of network performance due to unregulated traffic. Joint work with Tim Roughgarden, Henry Lin and Asher Walkover.

We will also mention results for a simple network design game, which is joint work with A. Dasgupta, E. Anshelevich and T. Wexler.

10:20	**Discussion**	
10:30	**Coffee Break**	Reception Room EE/CS 3-176
11:00	**Ruth J. Williams** University of California, San Diego	Fluid and Brownian Models of Congestion at Flow Level

Abstract: Massoulie and Roberts have introduced and studied a flow level model of Internet congestion control, that represents the randomly varying number of flows present in a network where bandwidth is dynamically shared between elastic document transfers.

In this talk, balanced fluid models and Brownian networks will be used to investigate the behavior of the flow level model in heavy traffic, under certain assumptions. Particular interest attaches to the phenomenon of entrainment, whereby congestion at some resources may prevent other resources from working at their full capacity.

This talk is based on joint work with Frank Kelly, Weining Kang and Nam Lee.

11:50	**Discussion**	
12:00	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.
12:30	**Lunch Break**	
2:00–3:00	**Panel Discussion**	The August 2003 Eastern U.S. Blackout Lessons and Questions for Transmission Network Policy, Control and Pricing

Panel members: Tom Overbye; Ross Baldick, Chris DeMarco.

Abstract: This panel will first review the events surrounding the U.S. blackout of August 2003. Using simulation and visualization tools, Tom Overbye will briefly illustrate the sequence and mechanisms of transmission equipment failures that led to cascading network failure and blackout. The discussion will use these events to motivate challenges faced in both shorter time scale control policies for allocating transmission resources, and longer term pricing policies to create incentive for "appropriate" transmission expansion. The panel and group discussion to follow will seek to lay groundwork for future work on mathematical models and analyses that might rationally inform the policy decisions facing the US power grid.
vspace3ex

Saturday, March 13

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176
9:30	**Thomas Overbye** University of Illinois, Urbana-Champaign	Power System Control: Enhancing the Human-System Interface

Abstract: Some of the operation of the electric grid is automated. However, this degree of automation is much lower than many people assume. Human operators are very much "in the loop," particularly during emergency situations such as during the time period leading up to the August 14th blackout. This work examines how delay in the human-system interface can adversely affect the operation of the grid, and then examines techniques to enhancing this interface, with the goal of reducing control delay. The work discusses methods for helping operators to quickly extract vital information from the large amount of power system data, and to translate this information into effective control actions.

10:20	**Discussion**	
10:30	**Coffee Break**	Reception Room EE/CS 3-176
11:00	**Christopher L. DeMarco** University of Wisconsin, Madison	A Phase Transition Model for Cascading Element Failures in Electric Power Networks

Abstract: The automated removal from service of branch elements and generation units experiencing overloads during large transient power flows in the electric grid played a significant role in the eastern U.S. blackout of August 2003. The work here develops a model of the electromechanical dynamics of the electric power grid, augmented by component models to

represent removal from service of transmission branches and generating units when a specified thresholds of branch flow or frequency excursion are exceeded. Assessing the impact of such protective thresholds on network dynamic response and control has long represented a severe challenge in power systems analysis, with heuristic selection of scenarios for time domain simulation representing the only practical approach in the industry. The representation developed here seeks to analytically capture relevant aspects of cascading failure, in which the outage of a network element stimulates further transient excursions in the system state, risking further overloads and element removals. We will demonstrate that with certain common approximations, the structure of the network dynamics with element failure admits a closed form Lyapunov function, and displays multiple stable equilibria associated with progressively degraded network configurations. The ability of the system to recover from one or more network element removals can then be assessed by judging whether or not the system trajectory is captured in the attractive basin of one of these equilibria. Moreover, the availability of a global Lyapunov function associated with the network dynamics provides a means of approximating these basins of attraction, with possibly for a tractable assessment of the impact of element protection thresholds.

11:50	**Discussion**	
12:00	**Second Chances**	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.
12:30	**Concluding Remarks by Organizers**	
12:40	**End of Workshop**	

Monday, March 15

The 3:00 IMA break will be in Lind Hall 400.

Tuesday, March 16

The 10:30 IMA break will be in Lind Hall 400.

IMA POSTDOC SEMINAR, 409 Lind Hall:

11:15-12:15	**Ilze Ziedins** University of Auckland, New Zealand	Optimal Routing in Parallel Tandem Queues with Loss

Abstract: In many queueing systems, individually optimal and socially optimal polices (whether for admission or routing) can be very different. This talk will look at a system of parallel finite tandem queues with loss. For this system, when customers choose routes that minimize their individual loss probability it can sometimes be optimal to choose queues with more customers already present and/or with greater residual service requirements (where preceding customers are further from their final destination). These individually optimal policies will be compared with socially optimal routing policies obtained in the limit as the number of possible routes becomes large. This is joint work with Ru-Shuo Sheu and Scott Spicer.

The IMA Postdoc Seminar is organized by
Antar Bandyopadhyay and Gerard Awanou.

SPECIAL SEMINAR, 409 Lind Hall:

1:30–2:30 **Tom Kurtz**
University of Wisconsin – Madison
Infinite Dimensional Semimartingales and Convergence of Stochastic Integrals

Abstract: Stochastic integration for finite-dimensional semimartingales will be reviewed briefly and extended to a class of infinite dimension semimartingales. The class includes space-time Poisson random measures, space-time Gaussian white noise, worthy martingale (random) measures in the sense of Walsh, and limits of empirical measures.

Wednesday, March 17

The 10:30 IMA break will be in Lind Hall 400.

SPECIAL SEMINAR, 409 Lind Hall:

1:30–2:30 **Tom Kurtz**
University of Wisconsin – Madison
Infinite Dimensional Semimartingales and Convergence of Stochastic Integrals

Abstract: The mapping that takes the integrand and integrator into the stochastic integral is not continuous. Consequently, convergence in distribution of a sequence of integrands and integrators does not necessarily imply convergence of the corresponding stochastic integrals. Conditions are given under which this implication is valid.

Thursday, March 18

The 10:30 IMA break will be in Lind Hall 400.

SPECIAL SEMINAR, 409 Lind Hall:

11–12 **Tom Kurtz**
University of Wisconsin – Madison
Infinite Dimensional Semimartingales and Convergence of Stochastic Integrals

Abstract: Applications of the convergence theorems will be given, including verification of diffusion approximations, averaging theorems, and consistency of simulation schemes.

COMPLEX SYSTEMS SEMINAR, Lind Hall 409:

1:30 **David McDonald**
University of Ottawa
Mean Field Convergence of a Rate Model of Multiple TCP Connections Through a Buffer Implementing RED

Abstract: (Joint work with J. Reynier.) RED (Random Early Detection) have been suggested when multiple TCP sessions are multiplexed through a bottleneck buffer. The idea is to detect congestion before the buffer overflows by dropping or marking packets with a probability that increases with the queue length. The objectives are an equitable distribution of packet loss, reduced synchronization together with reduced packet loss, delay, and delay variation.

Baccelli, McDonald and Reynier have proposed a rate model for multiple TCP connections in the congestion avoidance regime multiplexed through a bottleneck buffer implementing RED. The window sizes of each TCP session evolve like independent dynamical systems coupled by the queue length at the buffer. The key idea is to consider the histogram of window sizes as a random measure coupled with the queue. Here we prove the conjecture made in the earlier work that as the number of connections tends to infinity this system converges to a deterministic mean- field limit comprising the window size density coupled with a deterministic queue.

Friday, March 19

The 10:30 IMA break will be in Lind Hall 400.

Monday, March 22

The 3:00 IMA break will be in Lind Hall 400.

Tuesday, March 23

The 10:30 IMA break will be in Lind Hall 400.

IMA POSTDOC SEMINAR, 409 Lind Hall:

11:15-12:15	**Noam Berger** California Institute of Technology	Non-uniqueness for specifications in $\ell^{2+\epsilon}$

Abstract: Keane, Berbee and others have studied the question of which specifications (aka g-functions) admit a unique Gibbs measure. Bramson and Kalikow constructed the first example of a regular and continuous specification which admits multiple measures. For every $p > 2$, we construct a regular and continuous specification, whose variation is in ℓ^p, that admits multiple Gibbs measures. This shows that a recent condition of Oberg and Johansson is tight. Joint work with Christopher Hoffman and Vladas Sidoravicius.

The IMA Postdoc Seminar is organized by
Antar Bandyopadhyay and Gerard Awanou.

Wednesday, March 24

The 10:30 IMA break will be in Lind Hall 400.

BROWN BAG SEMINAR, Lind Hall 409:

12:00	**Chuan-Hsiang Han** IMA	Variance Reduction for Monte Carlo Methods to Evaluate Option Prices Under Multi-Factor Stochastic Volatility Models

Abstract: See http://www.ima.umn.edu/ğaroni/brownbag/index.html

The IMA Brown Bag Seminar is organized by
Tim Garoni and Tamon Stephen.

Thursday, March 25

The 10:30 IMA break will be in Lind Hall 400.

COMPLEX SYSTEMS SEMINAR, Lind Hall 409:

1:30 pm	**Arkady Khodursky** University of Minnesota	Spatial patterns of transcriptional activity in the chromosome of *Escherichia coli*

Abstract: We used a combination of genomic and signal processing techniques to investigate the properties of transcription in the genome of *Escherichia coli* as a function of the position of genes on the chromosome. Transcriptional activity of the bacterial chromosome was represented as a signal in a spatial domain. Analysis of the signal revealed the existence of a structure (patterns) in the spatial series of transcriptional activity. The statistically significant patterns could be classified on the basis of spatial ranges of correlations into three categories: i) short-range, over18-20 kbp; ii) medium-range, over 100-125 kbp; iii) long-range, over 600-800 kbp. Localization of structural components, initially defined in the overall

signal, revealed an asymmetry in the distribution of spatial patterns of transcription along the bacterial chromosome. We demonstrated that transcriptional patterns could be modulated pharmacologically and genetically, likely through interference with the DNA gyrase function. We observed that the distribution of DNA gyrase along the bacterial chromosome might play a critical role in the spatial pattern formation. All these observations taken together offer for the first time a strong evidence of physiologically determined higher-order organization of transcription in the bacterial chromosome.

Friday, March 26

The 10:30 IMA break will be in Lind Hall 400.

IMA/MCIM INDUSTRIAL PROBLEM SEMINAR, 570 Vincent Hall:

1:25pm **Ilya Kolmanovsky**, Ford Motor Company — Parameter Governors for Constrained Nonlinear Systems

Abstract: Pointwise-in-time state and control constraints represent some of the key challenges in many automotive powertrain control problems. Although for specific applications the engineers are usually successful in treating the constraints on a case-by-case basis, systematic control system design techniques that deal with constraints are of significant interest, and they hold promise to greatly reduce the development time and effort.

In particular, Model Predictive Control (MPC) provides a flexible and powerful framework for enforcing constraints while optimizing system performance. The MPC is based on an on-line dynamic optimization of the control input subject to constraints, over a receding horizon. By augmenting an MPC controller with on-line parameter estimation and accounting upfront for uncertainties and unmeasured disturbances in its design, robust constraint enforcement can be guaranteed At the same time, for memory and chronometrics limited automotive microcontrollers implementing a general MPC controller can be intricate. Suboptimal schemes that apply on-line optimization only to selected parameters in the nominal control laws can reduce the computational requirements and deal effectively with pointwise-in-time constraints. These reduced complexity embedded optimization (EO) algorithms are referred to as parameter governors.

The talk will start by reviewing some of the powertrain control applications in which dealing with constraints is an important priority. The parameter governors and their theoretical properties will be described next and illustrated with several examples. The results will be specialized to three classes of parameter governors that include reference governors, feed-forward governors and gain governors. Other applications of parameter governing-like ideas to on-line parameter estimation will be touched upon.

Monday, March 29

Special IMA Short Course:

Tools for Modeling and Data Analysis in Finance/Asset Pricing

29 March-2 April 2004

Speakers: Marco Avellaneda (Courant Institute of Mathematical Sciences), Blaise G. Morton (EBF Funds), Srdjan D. Stojanovic (University of Cincinnati), Carlos Fabian Tolmasky (Cargill, Inc.),

See http://www.ima.umn.edu/complex/spring/sc2.html

This tutorial recounts the state of the art in asset pricing theory and modeling. In many cases, models can be crucial for decision-making and the allocation of financial resources. Investment banks, often the most efficient users of capital, manage their trading portfolios using simulation models calibrated to hundreds of traded instruments. These models are used to price illiquid instruments as well as to manage the exposure of the firms to market and credit risk. The result

is a more efficient use of economic capital and, hopefully, a more transparent relation between financial institutions and regulators. Leading theoreticians and practitioners will lecture on the models used in the main asset classes.

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30	**Coffee and Registration**	Reception Room EE/CS 3-176
9:15	**Douglas N. Arnold, Scot Adams, and Organizers**	Welcome and Introduction
9:30-10:15	**Srdjan D. Stojanovic** University of Cincinnati	University of Cincinnati Stocks and Options: Integrating Data Analysis and Portfolio Optimization

Syllabus: 1. European Options. Derivation of the Black-Scholes PDE, and Monte-Carlo verification of the derivation. Black-Scholes formula. Effect of dividends. Comparison with the Cox, Ross, and Rubinstein binomial model. Time-dependent Black-Scholes formula. Options data. Elementary implied volatility.

2. American Options. Finite difference solution for the price-dependent Black-Scholes PDE. Early exercise possibility–optimal stopping problem. Finite difference solution of the free boundary (obstacle) problem for the Black-Scholes PDE. Dividend effect on the free boundary.

3. Portfolio Optimization. Self-financing portfolios. Merton's optimal portfolio theory. Merton's Hamilton-Jacobi-Bellman PDE and it's solution. Effect of incomplete information about appreciation rates. Optimal portfolios involving options. Other fully non-linear PDEs in portfolio optimization. Black-Scholes PDE re-derived via optimal portfolio theory. Stochastic volatility, and other extensions.

4. Inverse Problems. Derivation of the Dupire PDE. Non-elementary methods for implied volatility, and other parameter identification problems. Inverse problems for Dupire PDEs and obstacle problems. Regularization issues, finite difference solutions.

10:15–10:30	**Break**	Reception Room EE/CS 3-176
10:30–11:15	**Srdjan D. Stojanovic** University of Cincinnati	University of Cincinnati Stocks and Options: Integrating Data Analysis and Portfolio Optimization (Part 2)

Syllabus: See above.

11:15–1:30	**Lunch Break**	
1:30–2:15	**Srdjan D. Stojanovic** University of Cincinnati	University of Cincinnati Stocks and Options: Integrating Data Analysis and Portfolio Optimization (Part 3)

Syllabus: See above.

2:15–2:30	**Break**	Reception Room EE/CS 3-176
2:30–3:15	**Srdjan D. Stojanovic** University of Cincinnati	University of Cincinnati Stocks and Options: Integrating Data Analysis and Portfolio Optimization (Part 4)

Syllabus: See above.

Tuesday, March 30

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176
9:30–10:15	**Glenn J. Satty** Telluride Asset Management	Practical Aspects of Risk, Utility, and Derivative Valuation

Syllabus: 1. Utility and Behavior: practical examples of why rational people behave differently whether or not they have the same information, and how utility and behavior impact financial markets and pricing of financial instruments.

2. Fundamental Intuition behind Derivative Pricing: reducing the Black-Scholes equation and its solution to a "trading intuitive" form, in order to understand how traders and risk controllers use the equations and formulae in their daily work.

3. Relationship between Γ and Θ: how a market maker risk manages a position in real time. In this section we discuss ways a market maker makes money on both short and long term positions. If time permits we will also discuss classical portfolio insurance and its effect on the market.

4. Topics on Demand: according to the group we can discuss other issues, including different dynamics in different markets, actual vs theoretical distributions, exotic options, or other topics of interest. If time permits we may have a mock trading session.

10:15–10:30	**Break**	Reception Room EE/CS 3-176
10:30–11:15	**Glenn J. Satty** Telluride Asset Management	Practical Aspects of Risk, Utility, and Derivative Valuation (Part 2)

Syllabus: See above.

11:15–1:30	**Lunch Break**	
1:30–2:15	**Glenn J. Satty** Telluride Asset Management	Practical Aspects of Risk, Utility, and Derivative Valuation (Part 3)

Syllabus: See above.

2:15–2:30	**Break**	Reception Room EE/CS 3-176
2:30–3:15	**Glenn J. Satty** Telluride Asset Management	Practical Aspects of Risk, Utility, and Derivative Valuation (Part 4)

Syllabus: See above.

IMA Public Lecture:

Behavioral Finance - The Closed End Fund Puzzle

30 March 2004, 7:00 pm, Room 100 Smith Hall
Speaker: Stephen A. Ross (MIT)

See http://www.ima.umn.edu/public-lecture/2003-04/ross/index.html

5:00–6:30	**Reception**	Lind Hall 400
7:00	**Stephen A. Ross** Massachusetts Institute of Technology	Behavioral Finance - The Closed End Fund Puzzle Room 100 Smith Hall

Abstract: Frustrated by difficulties in explaining seemingly aberrant financial market behavior using contemporary methods of financial economics, a new school of behavioral finance has arisen that mixes psychology and economics. Despite the superficial appeal of this multi-disciplinary approach, this talk critiques behavioral finance by using the analytic tools of option pricing theory to solve a canoncial puzzle of behavioral finance - the closed end fund discount.

Wednesday, March 31

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176
9:30–10:15	**Carlos Fabian Tolmasky** Cargill, Inc.	Derivatives in Commodity Markets

Syllabus: 1. Generalities. Consumption and non-consumption commodities. Storage. Arbitrage relationships. Convenience yield. Contango, backwardation. Seasonality. Futures and Swaps. Mechanics: exchange traded contracts, over-the-counter contracts. Basis risk. Hedging. Example: Metallgesellschaft.

2. Description of some market structures and participants: metals, grains, energy (petroleum, natural gas, electricity), weather.

3. More on Swaps. Vanilla Options on futures. Spread options: craks, crush and timespread options. Asian options and options on swaps.

4. Term structure models. One factor models. Stochastic convenience yield. Gibson and Schwartz model. Statistics of various futures and volatility curves. Multicurve markets, intra and inter curve correlations.

5. Petroleum market revisited: the market as a description of a refinery and its economics.

10:15–10:30	**Break**	Reception Room EE/CS 3-176
10:30-11:15	**Carlos Fabian Tolmasky** Cargill, Inc.	Derivatives in Commodity Markets (Part 2)

Syllabus: See above.

11:15–1:30	**Lunch Break**

1:30–2:15	**Carlos Fabian Tolmasky** Cargill, Inc.	Derivatives in Commodity Markets (Part 3)

Syllabus: See above.

2:15–2:30	**Break**	Reception Room EE/CS 3-176

2:30–3:15	**Carlos Fabian Tolmasky** Cargill, Inc.	Derivatives in Commodity Markets (Part 4)

Syllabus: See above.

Thursday, April 1

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176

9:30–10:15	**Blaise G. Morton** EBF Funds	Quantitative Methods for Pricing Fixed-Income Securities (Based on notes by Blaise Morton and Thomas Spiegel)

Syllabus: 1. Introduction to Bonds and the Fixed-Income Markets. What is the market structure and who are the players. Basic models of Treasury Yield curves. Practical and philosophical issues with continuous yield curves. Back to reality with treasury, swap and agency dealer screens, quoting conventions. Treasury curve modeling techniques and basic analyses such as duration, convexity and the convexity bias. Understanding the shape of the treasury curve (following Ilmanen). A formula for expected bond return

2. Interest-Rate Swaps and the LIBOR Curve. Basic models. Building the LIBOR (rate) curve. Money market, interest-rate swaps and Eurodollar futures. The convexity bias in Eurodollar Futures (following Burghardt). The repo market – Basic trades and determining fair value. Definitions of spread trading and fixed-income arbitrage.

3. Stochastic Models and Derivatives Pricing. Black's model applied to pricing interest-rate caps, floors. Binomial trees for pricing callable bonds using the option-adjusted spread (OAS). PDE pricing models based on stochastic differential equations, example: the first convertible bond model of Brennan and Schwartz . Market Models, example: swaption pricing.

10:15–10:30	**Break**	Reception Room EE/CS 3-176

10:30–11:15	**Blaise G. Morton** EBF Funds	Quantitative Methods for Pricing Fixed-Income Securities (Based on notes by Blaise Morton and Thomas Spiegel) (Part 2)

Syllabus: See above.

11:15–1:30	**Lunch Break**

1:30–2:15	**Blaise G. Morton** EBF Funds	Quantitative Methods for Pricing Fixed-Income Securities (Based on notes by Blaise Morton and Thomas Spiegel) (Part 3)

Syllabus: See above.

2:15–2:30	**Break**	Reception Room EE/CS 3-176
2:30–3:15	**Blaise G. Morton** EBF Funds	Quantitative Methods for Pricing Fixed-Income Securities (Based on notes by Blaise Morton and Thomas Spiegel) (Part 4)

Syllabus: See above.

Friday, April 2

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	**Coffee**	Reception Room EE/CS 3-176
9:30–10:15	**Blaise G. Morton** EBF Funds	Quantitative Methods for Pricing Fixed-Income Securities (Based on notes by Blaise Morton and Thomas Spiegel) (Part 5)

Syllabus: See above.

10:15–10:30	**Break**	Reception Room EE/CS 3-176
10:30–11:15	**Blaise G. Morton** EBF Funds	Quantitative Methods for Pricing Fixed-Income Securities (Based on notes by Blaise Morton and Thomas Spiegel) (Part 6)

Syllabus: See above.

IMA/MCIM INDUSTRIAL PROBLEM SEMINAR, EE/CS 3-180:

NOTE CHANGE OF LOCATION

1:25	**Richard Derrig** OPAL Consulting LLC & U of Penn	Mathematical Models for Insurance Fraud Detection

Abstract: A discussion of some joint research with folks at the University of Texas on fraud detection via a binary classification of (insurance claim) characteristic vectors in n-space. This result fits into a "data mining" slot known as "unsupervised" learning, i.e., there are no known assignments to the two classes (fraud/ no fraud) but rather known or assumed responses (vector components) that are monotone in a latent variable (fraud/ no fraud). The origins of the technique are in educational testing (marketing) where the feature vectors are scored answers to questions and the latent variable is pass/fail (buy/no buy). Comparisons with other common modelling results for fraud and an application to structural changes in databases will be covered. No prior knowledge of insurance will be assumed or needed.

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PART III: CURRENT IMA PARTICIPANTS

FIRST YEAR POSTDOCTORAL MEMBERS

NAME	PREVIOUS INSTITUTION
Gerard Awanou	University of Georgia
Karen Ball	Indiana University
Antar Bandyopadhyay	UC Berkeley
Tim Garoni	University of Melbourne
Chuan-Hsiang Han	North Carolina State University
Lea Popovic	UC Berkeley

SECOND YEAR POSTDOCTORAL MEMBERS

NAME	PREVIOUS INSTITUTION
Olga Brezhneva	Russian Academy of Sci.
Herve Kerivin	University Blaise Pascal-France
Tamon Stephen	University of Michigan
Jing Wang	University of Minnesota

POSTDOCTORAL MEMBERS IN INDUSTRIAL MATHEMATICS

NAME	PREVIOUS INSTITUTION	INDUSTRIAL AFFILIATION
Lili Ju	Iowa State University	VA Hospital
Haewon Nam	Texas A & M University	GE
Jun Zhao	Texas A & M University	Schlumberger

LONG TERM VISITORS

NAME	HOME INSTITUTION
Greg Anderson	University of Minnesota
Hee-jeong Baek	Seoul National University (BK 21 Math-SNU)
Peter Bank	Humboldt University of Berlin
Maury Bramson	University of Minnesota
Rene Carmona	Princeton University
Rama Cont	Ecole Polytechnique
Wanyang Dai	Nanjing University
Shmuel Friedland	University of Illinois - Chicago
Naresh Jain	University of Minnesota
Mohammad Kazim Khan	Kent State University
Hye-Ryoung Kim	Seoul National University (BK 21 Math-SNU)
Thomas G. Kurtz	University of Wisconsin
Jeong Hyun Lee	Seoul National University (SRCCS)
Richard P. McGehee	University of Minnesota
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Greg Rempala	University of Louisville
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Mihai Sirbu	Carnegie Mellon
Srdjan Stojanovic	University of Cincinnati
Peter Tankov	Ecole Polytechnique
Hui Wang	Brown University
Yuhong Yang	Iowa State University
Ofer Zeitouni	University of Minnesota
Ilze Ziedins	University of Auckland

VISITORS IN RESIDENCE (as of 23 February 2004)

Vilen Abramov	Kent State University	3/27/04 – 4/02/04
Fernando L. Alvarado	University of Wisconsin	3/08/04 – 3/13/04
Valentin Andreev	Lamar University	3/28/04 – 4/02/04
Farshid Maghami Asl	University of Michigan	3/28/04 – 4/02/04

Ross Baldick	University of Texas - Austin	3/07/04 – 3/13/04
Hunt McCall Blatz	Advantus Capital Management	3/29/04 – 4/02/04
Amarjit Budhiraja	University of North Carolina	3/07/04 – 3/13/04
Mike Chen	University of Illinois	3/06/04 – 3/14/04
Zhiwei Chen	University of Maryland	3/28/04 – 4/02/04
Changho Choi	University of Minnesota	3/08/04 – 3/13/04
Gregory Ciresi	Courant Institute, New York University	3/28/04 – 4/02/04
J. G. ”Jim” Dai	Georgia Institute of Technology	3/06/04 – 3/13/04
Christopher L. DeMarco	University of Wisconsin	3/06/04 – 3/13/04
Shi-Jie Deng	Georgia Institute of Technology	3/06/04 – 3/11/04
Richard Derrig	Automobile Insurers Bureau, Massachusetts	3/30/04 – 4/03/04
Paul G Dupuis	Brown University	3/07/04 – 3/13/04
Daniel Ratton Figueiredo	University of Massachusetts - Amherst	3/07/04 – 3/13/04
Narryn Fisher	University of Maryland	3/27/04 – 4/02/04
Curt Flory	Agilent Technologies	3/04/04 – 3/05/04
Urmi Ghosh-Dastidar	City University of New York	3/28/04 – 4/02/04
Victor Goodman	Indiana University	3/28/04 – 4/02/04
Elliot C. Gootman	University of Georgia	3/28/04 – 4/03/04
George Gross	University of Illinois - Urbana-Champaign	3/07/04 – 3/13/04
Bruce Hajek	University of Illinois - Urbana-Champaign	3/06/04 – 3/13/04
Linhai He	University of California - Berkeley	3/07/04 – 3/14/04
Christopher V. Hollot	University of Massachusetts	3/07/04 – 3/13/04
Marija D. Ilic	Carnegie Mellon	3/07/04 – 3/13/04
Ramesh Johari	Massachusetts Institute of Technology	3/06/04 – 3/13/04
Anna R. Karlin	University of Washington	3/06/04 – 3/10/04
Prasanth Karumanchi	Purdue University	3/28/04 – 4/02/04
Peter Key	Microsoft Research	3/07/04 – 3/12/04
Sunhee Kim	University of Maryland	3/27/04 – 4/03/04
Boris Klebanov	Sungard Trading & Risk Systems	3/28/04 – 4/02/04
Leonid S. Kleinman	Morgan Stanley	3/28/04 – 4/02/04
Ilya Kolmanovsky	Ford Motor Company	3/25/04 – 3/26/04
Srisankar Kunniyur	University of Pennsylvania	3/06/04 – 3/13/04
Chang Hyeong Lee	University of Minnesota	3/29/04 – 4/02/04
Nam Lee	University of California - San Diego	3/06/04 – 3/13/04
Xiaoji Lin	University of Minnesota	3/29/04 – 4/02/04
Hantao Mai	University of Maryland	3/28/04 – 4/02/04
Peter Marbach	University of Toronto	3/07/04 – 3/13/04
David R. Mcdonald	University of Ottawa	3/07/04 – 3/20/04
Sean P Meyn	University of Illinois - Urbana-Champaign	3/06/04 – 3/11/04
Oana Mocioalca	Purdue University	3/28/04 – 4/02/04
Mahdi Nezafat	University of Minnesota	3/07/04 – 3/13/04
Andrew M. Odlyzko	University of Minnesota	3/08/04 – 3/12/04
Teun Ott	New Jersey Institute of Technology	3/07/04 – 3/13/04
Thomas Overbye	University of Illinois - Urbana-Champaign	3/09/04 – 3/13/04
Asuman E. Ozdaglar	MIT Sloan School of Management	3/06/04 – 3/10/04
Christos Papadimitriou	University of California - Berkeley	3/07/04 – 3/13/04
Georgia Perakis	Massachusetts Institute of Technology	3/08/04 – 3/09/04
Thomas J. Peters	University of Connecticut	3/28/04 – 4/02/04
H K Pradhan	XLRI Jamshedpur	3/28/04 – 4/02/04
Geoffrey Pritchard	University of Auckland	3/06/04 – 3/13/04
Kavita Ramanan	Lucent Technologies	3/03/04 – 3/15/04
Martin Reiman	Lucent Technologies	3/06/04 – 3/13/04
Sara Robinson	SIAM	3/06/04 – 3/13/04
Stephen Ross	Massachusetts Institute of Technology	3/29/04 – 3/30/04
Tim Roughgarden	Cornell University	3/09/04 – 3/12/04
Sujay Sanghavi	University of Illinois - Urbana-Champaign	3/06/04 – 3/12/04

Jamie Seguino	Ford Motor Company	3/28/04 – 4/04/04
Jonathan Shapiro	Michigan State University	3/06/04 – 3/13/04
A. Christian Silva	University of Maryland	3/28/04 – 4/02/04
R. Srikant	University of Illinois - Urbana-Champaign	3/06/04 – 3/10/04
Alexander Stolyar	Lucent Technologies	3/07/04 – 3/13/04
Eva Tardos	Cornell University	3/06/04 – 3/12/04
Sekhar Tatikonda	Yale University	3/08/04 – 3/13/04
Gary Nan Tie	The St. Paul Companies	3/29/04 – 4/02/04
John N. Tsitsiklis	Massachusetts Institute of Technology	3/08/04 – 3/12/04
Pradyumna S. Upadrashta	University of Minnesota	3/29/04 – 4/02/04
George Verghese	Massachusetts Institute of Technology	3/06/04 – 3/11/04
Milan Vojnovic	Swiss Federal Institute of Technology	3/07/04 – 3/13/04
Jean Walrand	University of California - Berkeley	3/07/04 – 3/13/04
Hong Wang	University of Minnesota	3/29/04 – 4/02/04
Xiaodi Wang	Western Connecticut University	3/07/04 – 3/14/04
Xiaodi Wang	Western Connecticut University	3/28/04 – 4/03/04
John Ting-Yung Wen	Rensselaer Polytechnic Institute	3/06/04 – 3/12/04
Jacek Wesolowski	Warsaw University of Technology	2/23/04 – 3/03/04
Ruth Williams	University of California - San Diego	3/05/04 – 3/19/04
Richard Yang	Yale University	3/06/04 – 3/13/04
Sichao Yang	University of Illinois - Urbana-Champaign	3/06/04 – 3/13/04
Edmund Yeh	Yale University	3/07/04 – 3/13/04
William Yurcik	University of Illinois - Urbana-Champaign	3/06/04 – 3/13/04
Bing Zhang	University of Maryland	3/28/04 – 4/03/04
Tao Zhang	Purdue University	3/27/04 – 4/02/04
Yuming Zhang	University of Maryland	3/28/04 – 4/02/04
Zhi-Li Zhang	University of Minnesota	3/07/04 – 3/13/04

See also URL: `http://www.ima.umn.edu/people/`